A STUDY ON THYROID PROFILE IN TYPE 2 DIABETES MELLITUS

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BONAFIDE CERTIFICATE

This is to certify that **"A STUDY ON THYROID PROFILE IN TYPE 2 DIABETES MELLITUS"** is a bonafide work done by **Dr.V.RAJAKUMAR**, post graduate student, Department of General Medicine, Kilpauk Medical College, Chennai-10, under my guidance and supervision in partial fulfillment of regulations of **The Tamilnadu Dr.M.G.R.Medical University** for the award of **M.D.Degree Branch I, (General Medicine)** during the academic period from May 2007 to March 2010.

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CONTENTS

INTRODUCTION

Diabetes mellitus is a common endocrine disorder which involves multiple organ systems and leads to significant morbidity and mortality due to accompanying complications.

Diabetes mellitus has been defined as "A metabolic syndrome characterised by chronic hyperglycaemia and disturbance of carbohydrate, fat and protein metabolism associated with absolute or relative deficiency in insulin secretion and or insulin action".

Much has been accomplished in the field of diabetes but what has been troubling one and all are the large macrovascular and micro vascular complications of diabetes involving kidneys, eyes, blood vessels, nerves and heart.Thyroid diseases are also a common endocrinopathy seen in the adult population. Thyroid hormones are intimately involved in cellular metabolism.

Thus excess or deficit of either insulin or thyroid hormones could result in the functional derangement of the cellular metabolism.

The present work is a modest attempt to study the prevalence of thyroid disorders in patients with type 2 diabetes mellitus.

AIM OF THE STUDY

1. To study the prevalence of thyroid disorders in patients with type 2 diabetes mellitus.
2. To study the distribution of thyroid disorders in patients with type 2 diabetes mellitus regarding age, sex, duration of diabetes, type of treatment, family history of diabetes mellitus, comorbid conditions, BMI and serum lipid profile.
3. To evaluate the relationship between glycemic control and occurrence of altered thyroid function in type 2 diabetes mellitus.

REVIEW OF LITERATURE

Diabetes mellitus is characterised by chronic hyperglycemia with disturbances of carbohydrate, fat, and protein metabolism resulting from defects in insulin secretion, insulin action, or both.[1] The metabolic dysregulation associated with DM causes secondary pathophysiologic changes in multiple organ systems that impose a tremendous burden on the individual with diabetes and on the health care system. [2]

PROBLEM STATEMENT

In the first edition of the *IDF Diabetes Atlas*, released in 2000, the estimated global diabetes prevalence was 151 million. Now the estimated diabetes prevalence for 2010 has risen to 285 million, representing 6.4% of the world's adult population, with a prediction that by 2030 the number of people with diabetes will have risen to 438 million. Far from being a disease of higher income nations, diabetes is very much a disease associated with poverty and disproportionately affecting the lower socio-economic groups. [3] Previously a disease of the

middle aged and elderly, type 2 diabetes has recently escalated in all age groups and is now being seen in younger age groups.[4]

Unfavourable modification of lifestyle and dietary habits with urbanisation are the most important factors for the development of diabetes. The percentage of diabetic cases in urban areas is projected to increase from 54% in 1995 to 73% by the year 2025.[5] According to IDF(2009),India has the highest number of people suffering from diabetes mellitus with 50.8 million and spends 2.8 billionUS$ or 1% of the global health expenditure for diabetes and related problems. [6]

United Nations in 2006 in Resolution 61/225 stated that “diabetes is a chronic, debilitating and costly disease associated with severe complications, which poses severe risks for families, Member States and the entire world”.[7]

HISTORY

Diabetes is as old as medicine. Early evidence of description of symptoms of diabetes recorded in the Ebers papyrus, 1550 B.C.[8] Arateus (30-90 AD), coined the term *diabetes*, meaning “siphon,” to explain the “liquefaction of the flesh and bones into urine”. In Greek this word

means 'to run through' that describes 'unquenchable thirst' seen in association with this disease.[9] Shushruta (Circa 600AD) noted this disease in Ayurveda and described it as "Madhumeha".[10]

. In 1869, Paul Langerhans, published in his dissertation on pancreatic histology described “clumps of cells,” which were named the *islets of Langerhans* shortly after his death.[11,12] In 1889, Minkowski and Von Mering, in Strassburg, Germany, discovered the central role of the pancreas in diabetes.[13] In 1910, Jean de Meyer suggested that the pancreatic secretion lacking in diabetic state to be called as “Insulin” to denote it’s origin from insulae of Langerhans.[14] Banting and Charles Best in 1921, extracted insulin from dog's pancreas.[15]

The first chemical application of insulin was on 14 year old Leon and Thompson, a patient of diabetic ketoacidosis in January 1922 in Canada. This discovery revolutionized the management of diabetes. Oral hypoglycaemic drugs were introduced by Frank and Fuchs in 1955.[8]

DESCRIPTION OF DIABETES MELLITUS

When fully expressed, diabetes is characterized by fasting hyperglycemia, but the disease can also be recognized during less overt stages, most usually by the presence of glucose intolerance.

Diabetes may present with characteristic symptoms such as thirst, polyuria,blurrin of vision,weight loss and polyphagia.Hyperglycemia sufficient to cause pathologic functional changes may quite often be present for a long time before the diagnosis is made.[1]

Patients may revert to having impaired glucose regulation or even normal glycemia, particularly in recent-onset type 2 diabetes.[16] In type 1 diabetes, after a short period of insulin treatment, there may be a variable period when insulin is no longer required for survival and glucose tolerance may improve, the so-called honeymoon period. Eventually such patients do need insulin treatment for survival.[17]

Etiologic Classification of diabetes mellitus[2]

I. Type 1 diabetes

A. Immune mediated

B. Idiopathic

II. Type 2 diabetes

III. Other specific types

A. Genetic defects of ß-cell function

B. Genetic defects in insulin action

C. Diseases of the exocrine pancreas

D. Endocrinopathies

E. Drug- or chemical induced

F. Infections

G. Uncommon forms of immune-mediated diabetes

H. Other genetic syndromes sometimes associated with diabetes

IV. Gestational diabetes mellitus (GDM)

The majority of cases of diabetes fall into two broad etiopathogenetic categories, now called type 1 and type 2 diabetes.

TYPE 1 DIABETES MELLITUS

Type 1 diabetes is the form of the disease due primarily to β-cell destruction in which insulin is required for survival. It is characterized by the presence of anti-GAD, anti-islet cell, or anti-insulin antibodies, which reflects the autoimmune processes that have led to β-cell destruction.[18,19]

TYPE 2 DIABETES MELLITUS

Type 2 diabetes is the most common form of diabetes. Insulin resistance and abnormal insulin secretion are central to the development of type 2 DM.[2] Patients with type 2 diabetes usually have insulin resistance and relative, rather than absolute, insulin deficiency and are associated with progressive β-cell failure with increasing duration of diabetes.[20] The risk of developing type 2 diabetes increases with age, obesity, physical inactivity and family history of diabetes.[1] The disease can occur at any age and is now seen in children and adolescents.[21]

Diagnostic criteria for diabetes mellitus[22]

Symptoms of diabetes plus random plasma glucose concentration ≥ 200 mg/dl (11.1 mmol/l). Random is defined as any time of day without regard to time since last meal. The classic symptoms of diabetes include polyuria, polydipsia and unexplained weight loss (or)

FPG ≥ 126 mg/dl (7.0 mmol/l). Fasting is defined as no caloric intake for at least 8 hours. (or)

2 hours post load glucose ≥ 200 mg/dl (11.1 mmol/l) during an OGTT. The test should be performed as described by WHO, using a glucose load containing the equivalent of 75 gm anhydrous glucose dissolved in water.

In the absence of unequivocal hyperglycaemia these criteria should be confirmed by repeat testing on a different day. FPG is the most reliable and convenient test for identifying DM in asymptomatic individuals. HbA_{1C} is not currently recommended to diagnosis of diabetes.

IMPAIRED GLUCOSE TOLERANCE[1]

Defined as 2 hours values in the oral glucose tolerance test (OGTT) between 140 and 199mg/dl (7.8 and 11.1 mmol/L). Glucose tolerance is above the conventional normal range but lower than the level diagnostic of diabetes. Persons with IGT have a high risk of developing diabetes and arterial disease. IGT is more frequent in obese persons and often is associated with hyperinsulinemia and insulin resistance.

IMPAIRED FASTING GLUCOSE[1]

Defined as fasting plasma glucose concentrations of 100 to 125 mg/dL (5.6 to <7.0 mmol/L). IFG is also a stage of impaired glucose

homeostasis with fasting glucose levels were above normal but below those diagnostic for diabetes.

ACUTE COMPLICATIONS OF DM[2]

Diabetic ketoacidosis (DKA) and hyperglycemic hyperosmolar state (HHS) are acute complications of diabetes. DKA primarily occurs in type 1 DM but, can also occur in type 2 DM. HHS is primarily seen in individuals with type 2 DM. Both disorders are associated with absolute or relative insulin deficiency, volume depletion, and acid-base abnormalities.

CHRONIC COMPLICATIONS OF DM[2]

The vascular complications of DM are divided into microvascular (retinopathy, neuropathy, nephropathy) and macrovascular complications [coronary artery disease (CAD), peripheral arterial disease (PAD), cerebrovascular disease]. Nonvascular complications include problems such as gastroparesis, infections, and skin changes.

The microvascular complications of both type 1 and type 2 DM result from chronic hyperglycemia. Evidence implicating a causative role

for chronic hyperglycemia in the development of macrovascular complications were inconclusive. Other factors (dyslipidemia and hypertension) also play important roles in macrovascular complications.

DYSLIPIDEMIA IN DIABETES

The dyslipidemia in type 2 diabetes and insulin resistance typically consists of elevated triglycerides and decreased HDL cholesterol level[23] and of qualitative abnormality in the LDL structure, i.e., decreased size and increased density of the LDL particle.[24]

METABOLIC SYNDROME AND OBESITY[25]

The metabolic syndrome (syndrome X, insulin resistance syndrome) consists of a constellation of metabolic abnormalities that confer increased risk of cardiovascular disease (CVD) and diabetes mellitus (DM). Diagnosis of the metabolic syndrome requires the presence of at least three of the following five criteria:[26]

1. elevated fasting plasma glucose levels (>110 mg/dL),

2. visceral obesity (waist circumference >35 inches in women and 40 inches in men),
3. hypertension (>130/85 mm Hg),
4. hypertriglyceridemia (>150 mg/dL) and
5. low high-density lipoprotein (HDL) cholesterol (<40 mg/dL in men and <50 mg/dL in women)

THYROID

The thyroid (Greek *thyreos*, shield, plus *eidos*, form) consists of two lobes that are connected by an isthmus. It is located anterior to the trachea between the cricoid cartilage and the suprasternal notch. Four parathyroid glands, which produce parathyroid hormone are located posterior to each pole of the thyroid.[27]

The normal thyroid gland secretes sufficient amounts of the thyroid hormones **triiodothyronine (T_3)** and **tetraiodothyronine (T_4, thyroxine)** to normalize growth and development, body temperature, and energy levels. Calcitonin, the second type of thyroid hormone, is important in the regulation of calcium metabolism.[28]

BIOSYNTHESIS OF THYROID HORMONES[27]

Iodide, ingested from food, water, or medication, is rapidly absorbed from intestine and enters an extracellular fluid pool. Transport of iodide into the thyroid gland is by an intrinsic follicle cell basement membrane sodium/iodide symporter (NIS). At the apical cell membrane a second I^- transport enzyme called pendrin is present. Iodide is oxidized by thyroidal peroxidase to iodine that rapidly iodinates tyrosine residues within the thyroglobulin molecule to form monoiodotyrosine (MIT) and diiodotyrosine (DIT). This process is called **iodide organification.**Two molecules of DIT combine within the thyroglobulin molecule to form L-thyroxine (T_4). One molecule of MIT and one molecule of DIT combine to form T_3. T_4, T_3, MIT, and DIT are released from thyroglobulin by exocytosis and proteolysis of thyroglobulin at the apical colloid border. Most of the hormone released is thyroxine. Most of the T_3 circulating in the blood is derived from peripheral metabolism of T_4.

Both hormones are bound to plasma proteins, including thyroxine binding globulin (TBG); transthyretin (TTR); and albumin. The plasma binding proteins increase the pool of circulating hormone, delay

hormone clearance, and may modulate hormone delivery to selected tissue sites.

DEIODINASES[27]

T_4 is converted to T_3 by the deiodinase enzyme.

1. Type I deiodinase, which is located primarily in thyroid, liver, and kidney, has a relatively low affinity for T_4.
2. Type II deiodinase has a higher affinity for T_4 and is found primarily in the pituitary gland, brain, brown fat, and thyroid gland.
3. Type III deiodinase inactivates T_4 and T_3 and is the most important source of reverse T_3 (r T_3)

PHYSIOLOGICAL EFFECTS OF THYROID HORMONES[29]

Heart : Increases number of β adrenergic receptors

Enhances response to catecholamines

Adipose tissue : Stimulate lipolysis

Muscle : Increases protein breakdown

Bone : Promote growth and development

Nervous system : Promote normal brain development

Gut : Increases carbohydrate absorption

Lipoprotein : Stimulate LDL receptors

Others : Increases metabolic rate and oxygen consumption

REGULATION OF THYROID AXIS[27]

The thyroid axis is a classic example of an endocrine feedback loop. TRH stimulates pituitary production of TSH, which, in turn, stimulates thyroid hormone synthesis and secretion. Thyroid hormones feed back to inhibit TRH and TSH production .

EXOGENOUS AND ENDOGENOUS FACTORS SUPPRESSING TSH SECRETION:[30]

Dopamine and agonists, Somatostatin, Dobutamine, Glucocorticoids, Interleukins, TNF-α, Thyroid hormones and Phenytoin.

FACTORS ASSOCIATED WITH ALTERED BINDING OF THYROXINE BY THYROXINE-BINDING GLOBULIN[30]

Increased Binding:

Pregnancy, Oral contraceptives, Infectious hepatitis, Cirrhosis, HIV, Acute intermittent porphyria and Tamoxifen.

Decreased Binding

Androgens, Large doses of glucocorticoids, acromegaly, Nephrotic syndrome , Major systemic illness and Psychiatric illness.

FACTORS ASSOCIATED WITH DECREASED CONVERSION OF T_4 TO T_3:[30]

Fetal life, Caloric restriction, Hepatic disease, Major Systemic illness, Propylthiouracil, Glucocorticoids, Propranolol, Iodinated X-ray contrast agents, Amiodarone and Selenium deficiency.

HYPOTHYROIDISM

Hypothyroidism is the condition resulting from a lack of effects of thyroid hormones on body tissues.[31]

Symptoms

Tiredness, weaknes, Dry skin ,Feeling cold,Hair loss, Difficulty concentrating and poor memory, Constipation, Weight gain with poor appetite,Dyspnea,Hoarse voice, Menorrhagia (later oligomenorrhea or amenorrhea), Paresthesia and Impaired hearing.

Signs

Dry coarse skin; cool peripheral extremity, Puffy face, hands, and feet (myxedema), Diffuse alopecia, Bradycardia, Peripheral edema, Delayed tendon reflex relaxation, Carpal tunnel syndrome and Serous cavity effusions[27]

METABOLIC ABNORMALITIES IN HYPOTHYROIDISM

Hypothyroidism is associated with a reduction in glucose disposal to skeletal muscle and adipose tissue and also associated with reduced gluconeogenesis. The net effect of these influences is usually minimal on serum

glucose levels. Degradation of insulin, is slowed and the sensitivity to exogenous insulin may be increased.[32] Both the synthesis and the degradation of lipid are depressed in hypothyroidism with a net effect of accumulation of LDL and triglycerides. HDL concentrations and Plasma free fatty acid levels are decreased.[33].

SUBCLINICAL HYPOTHYROIDISM

Defined as a low-normal free T_4 but a slightly elevated serum TSH level. The TSH elevation in such patients is modest, with values typically between 4 and 15 mU/L.[33] Rates of progression to overt hypothyroidism ranges from 3% to 8% per year, higher rates seen in individuals with initial TSH concentration greater than 10 mU/L and those with positive anti-TPO antibodies.[34] The association of mild hypothyroidism with an increase in risk for atherosclerotic heart disease has been shown by some, but not others.[35,36] .

HYPERTHYROIDISM[27]

Hyperthyroidism is a state when thyrotoxicosis occurs because of sustained over production of hormones by thyroid gland.

Symptoms

Heat intolerance and sweating, Palpitation, Fatigue and weakness, Weight loss with increased appetite, Diarrhea, Polyuria, Oligomenorrhea, and loss of libido.

Signs

Tachycardia; atrial fibrillation in the elderly, Tremor, Goiter, Warm, moist skin,Muscle weakness, proximal myopathy, Lid retraction or lag and Gynecomastia.

METABOLIC ABNORMALITIES IN HYPERTHYROIDISM

Preexisting diabetes mellitus may be aggravated, one cause being accelerated turnover of insulin.[37] Both lipogenesis and lipolysis are increased in thyrotoxicosis, but the net effect is lipolysis, as reflected by an increase in the plasma concentration of free fatty acids and glycerol and a decrease in serum cholesterol level.Triglyceride levels are usually slightly decreased.[38]

SUBCLINICAL HYPERTHYROIDISM

There are no signs of thyrotoxicosis but the serum TSH is subnormal despite normal serum free T_4 concentration.[37] Subclinical hyperthyroidism may

accelerate bone loss in postmenopausal women[39] and increases the incidence of atrial arrhythmias including atrial fibrillation in elderly patients.[31]

DIABETES AND THYROID DISEASES

Diabetes mellitus and thyroid diseases are the two common endocrinopathies seen in the adult population. Insulin and thyroid hormones are intimately involved in cellular metabolism. Excess or deficit of either of these hormones could result in the functional derangement of the other.[40]

EFFECT OF DIABETES ON THYROID FUNCTION

In euthyroid individuals with diabetes mellitus, the serum T_3 levels, basal TSH levels and TSH response to thyrotropin releasing hormone (TRH) may all be strongly influenced by the glycemic status.[41] Poorly controlled diabetes, both Type 1 and Type 2, may induce a "Low T_3 state" characterized by low serum total and free T_3 levels, increase in reverse T_3 (r T_3) but near normal serum T_4 and TSH concentrations.[42] Low serum T_3 is due to reduced peripheral conversion of thyroxine (T_4) to tri-iodothyronine (T_3) via 5' monodeiodination reaction and may normalize with improvement in glycemic status but even with good diabetes control, the normal nocturnal TSH peak may not be restored in

C-peptide negative patients.[43]

EFFECT OF DIABETES MELLITUS ON THYROID DISEASES

Dysthyroid optic neuropathy (DON) resulting in blindness is the most threatening complication of Graves' orbitopathy (GO). It is due to the compression of optic nerve by enlarged extraocular muscles at the orbital apex. Incidence of DON in patients with diabetes mellitus is higher than that seen in control "GO" group and the recovery after treatment is also poor. This has been explained by reduced oxygenation of optic nerve in diabetic patient owing to the vasculopathy making it more susceptible to the pressure effect.[44]

EFFECT OF HYPERTHYROIDISM ON GLYCEMIC STATUS

Graves disease is the commonest cause of hyperthyroidism. While Graves disease may be associated with type 1 diabetes in polyglandular autoimmune syndrome, thyrotoxicosis by itself is diabetogenic. Frank diabetes occurs in 2-3%, when hyperthyroidism develops in normal individuals. In known diabetic

patients hyperthyroidism causes deterioration of glycemic control status.[42] These changes are due to alteration in following systems:-

1. Gastrointestinal System

In hyperthyroidism, there is accelerated gastric emptying, enhanced intestinal glucose absorption and an increase in portal venous blood flow.[44]

2. Insulin Secretion

Insulin secretion decreases in hyperthyroidism.[45,46] Insulin clearance rate is reported to be increased by about 40%.[47] Long term thyrotoxicosis has been shown to cause beta cell dysfunction resulting in poor insulin response to glucose.[48]

3. Endogenous Glucose Production

In hyperthyroidism the endogenous glucose production is greatly increased by a variety of mechanisms: (a) there is an increase in the availability of gluconeogenic precursors(lactate, glutamine, alanine and FFA) stimulating hepatic gluconeogenesis;[49] (b) Inhibition of glycogen synthesis;[50]

(c) Upregulation of GLUT-2 glucose transporters protein expression in the hepatocyte;[51] (d) Increased secretion and exaggerated effects of glucagon and adrenaline on liver cells.[49]

4. Glucose utilization

In adipocytes isolated from rats, the sensitivity of glucose transport and utilization to insulin has been found to be normal, increased or decreased.[45] In skeletal muscle, there is a preferential increase in glucose uptake and lactate formation . This is due to increase in GLUT-1 and GLUT-4 transporters[52], increased glycogenolysis due to beta adrenergic stimulation[49] ,increased activity of hexokinase and 5 phosphofructokinase.[53]

Thus the net effect of changes occurring at various levels such as gastrointestinal tract, beta cells, hepatocytes, adipocytes and skeletal muscles is hyperglycemia.

EFFECT OF HYPOTHYROIDISM ON GLYCEMIC STATUS

In hypothyroidism, the synthesis and release of insulin is decreased.[46] The rate of hepatic glucose output is decreased probably due to reduced gluconeogenesis. A post receptor defect has been proposed to explain the

decrease in insulin stimulated glucose utilization in peripheral tissues.[49] The net effect is an increased risk of recurrent hypoglycemia in a diabetic individual.[54]

ASSOCIATION BETWEEN DIABETES MELLITUS AND THYROID DISORDERS:

Celani MF et al in their study found that abnormal TSH values in type 2 diabetic patients found before tight glycemic control reverted to normal values with adequate treatment of diabetes with OHA or insulin. They suggested that the diagnosis of thyroid dysfunction in type 2 diabetes should be delayed until improvement of metabolic status.[55]

Proces S et al in their study found that in diabetic patients TSH was lower than in non diabetic subjects. They concluded that besides known parameters such as age and drugs, thyroid function tests can also be altered in diabetes mellitus and obesity.[56]

Warren RE et al in their study found that serum thyrotropin (i.e. baseline TSH) is a better predictor of thyroid dysfunction than thyroid autoantibodies in people with diabetes.[57]

Vondra K et al in their study found that prevalence of thyroid disease in

diabetic patients is 2-3 times higher than in non diabetic subjects. It raises with age and is strongly influenced by female gender and autoimmune diabetes. They even recommended thyroid disease screening and diagnosis in patients with diabetes mellitus.[58]

Abdel Rahman et al in their study found that overall prevalence of thyroid diseases was 12.5% in type 2 diabetes mellitus group. The study suggested that diabetic patients should be screened for asymptomatic thyroid dysfunction.[59]

Perros P et al in their study found that the prevalence of thyroid disease was 13.4% in a randomly selected group of 1310 adult diabetic patients attending a diabetic clinic. They suggested that thyroid function should be screened annually in diabetic patients to detect asymptomatic thyroid dysfunction which is increased in frequency in a diabetic population.[60]

Smithson MJ in his study found that the prevalence of thyroid disease (previously known and diagnosed as a result of screening) in the entire population of diabetic patients in his sample of 4300 general practice patients was 10.8%. He concluded by suggesting that screening for thyroid disease should be considered in patients receiving diabetes care in community.[61]

Zdrojewicz Z et al in their study found that there was no difference in

thyroid gland function in patients with non insulin dependent diabetes mellitus(type 2) and different therapies have no influence on thyroid gland function.[62]

Parr JH et al in their study found that improvement in long term metabolic control did not influence free thyroid hormone levels in well controlled and moderately-poor controlled diabetics taking insulin.[63]

Chubb SA et al in their study found that none of those patients with type 2 diabetes diagnosed of subclinical hypothyroidism has overt hypothyroidism when restudied after 5 years. So they concluded that subclinical hypothyroidism is a common but incidental finding and routine screening of thyroid function in type 2 diabetes is questionable.[64]

MATERIALS AND METHODS

The present study titled ***"Thyroid Profile in Type 2 Diabetes Mellitus"***

was carried out in the Department of Medicine and in the Department of Diabetology, kilpauk medical college and hospital (Chennai).

1. **Study design :** Cross sectional study.

2. **Period of study:** January 2009 to October 2009

3. **Materials :** Questionnaire, BMI calculation, Blood pressure, FBS, PPBS, Blood Urea, Serum creatinine,, Urinalysis, urine spotPCR (Protein Creatinine Ratio),ECG, Chest X ray, Fasting lipid profile, Thyroid profile(FT_3, FT_4 and TSH), HbA_{1C}, Fundus examination.

4. **Study group :** The study group included 108 persons with known type 2 diabetes mellitus or newly detected Type 2 diabetes mellitus with out known thyroid disorders either admitted in wards or attending the outpatient departments who met the inclusion criteria.

Inclusion criteria

Known type 2 diabetes mellitus and Newly detected type 2 diabetes mellitus subjects who gave informed consent to participate in the study.

Exclusion criteria

- Patients not willing for study

- Patients with known thyroid disease
- Patients with chronic renal failure and Diabetic nephropathy.
- Patients with acute illness(sepsis, acute MI, severe heart failure, recent admission in intensive care unit)
- Patients with hepatic dysfunction
- Patients with psychiatric illness.
- Pregnancy
- Patients on treatment with drugs interfering with thyroid function (amiodarone, propranolol, corticosteroids and oral contraceptives)

All patients in the study group were selected without any bias for sex, duration, severity or control of diabetes. A thorough history was recorded with particular emphasis on symptoms of hypothyroidism and hyperthyroidism. The presence of associated illness like coronary artery disease, hypertension and cerebrovascular accident were noted. Family history regarding diabetes mellitus and treatment history of oral hypoglycaemics or insulin along with duration was also included.

A thorough general and systemic examination was carried. The fundus

examination for diagnosis of diabetic retinopathy and neurological examination for diabetic neuropathy were also done.

BMI calculation

Body mass index (BMI) is calculated with height and weight of the subject using the following formula.

$$BMI = \text{weight (kg)} / \text{height (m)}^2$$

Blood sugar

Both fasting and postprandial blood sugar are estimated by Trinder's (Glucose oxidase) method and read at 505/670 nm.

Renal function test

The Blood Urea in this study was estimated using DAM method (Diacetyl Monoxime). Serum creatinine was estimated using Modified Jaffe's method.

Urinalysis

Urine sample is collected for urine routine analysis which includes sugar, protein, cytology and urinary sediments

Urine spot PCR

Urine sample is collected to estimate protein creatinine ratio. Sulfo salicylic precipitation method used for protein estimation.

Lipid Profile

Total cholesterol,Triglyceride (TGL), Low Density Lipoprotein (LDL) and High Density Lipoprotein (HDL) levels were analysed in the early morning fasting Blood Sample.

Methods used:

1. Total cholesterol- CHOD POD METHOD
2. HDLC -Selective immune precipitation method
3. Triglycerides - Enzymatic calorimetric method
4. LDLC - Derived from TC and TGL values.
5. VLDL - Derived from triglyceride values

HbA_{1C}

Blood sample collected in EDTA coated tubes and HbA_{1C} is estimated by Biorad- HPLC method.

Thyroid Profile

Estimation done in fasting serum sample.

Methods used:

1.TSH - Ultrasensitive sandwich chemi luminescent immuno assay

2. FT_3 & FT_4 - Competitive chemi luminescent immuno assay.

DEFINITIONS

Diabetes Mellitus

The WHO in consultation with an expert committee of the American Diabetes Association has approved the following diagnostic criteria for Diabetes Mellitus,which was used to diagnose new cases.

The patients on antidiabetic therapy were also considered as having diabetes mellitus.

Fasting: No caloric intake for atleast 8 hours.

2-3 days of unrestricted carbohydrated diet prior to the test.

No physical activities during the procedures.

Systemic Hypertension (As per the JNC VII Guidelines)

Subjects on medications for hypertension and those who had a systolic blood pressure of ≥ 140 mmHg and / or diastolic blood pressure ≥ 90 mmHg were considered to have hypertension.

Dyslipidemia

Adult Treatment Panel III (ATP III) guidelines developed by the National Cholesterol Education Program have been used to detect dyslipidemia in the study subjects. Diabetes mellitus is considered as Coronary Heart Disease equivalent. According to the guidelines:

Overweight and Obesity

BMI (WHO criteria for Asian population) is used for classifying the subjects according to the weight status.

BMI Group	BMI(kg/m^2)
Underweight	< 18.5
Normal weight	18.5-22.9
Overweight	23-29.9
Obesity	≥ 30.0

Thyroid profile

Reference values: FT_3 : 1.7-4.2 pg/ml TSH : 0.35-5μIU/ml

FT_4 : 0.7- 1.8 ng/dl

- Overt hypothyroidism is defined as TSH >5.5 μIU/ml with FT_4 < 0.7 ng/dl.
- Subclinical hypothyroidism is defined as TSH > 5μIU/ml with normal FT_3 and FT_4 levels
- Overt hyperthyroidism is defined as TSH < 0.3 μIU/ml with FT_4 > 1.8 ng/dl
- Subclinical hyperthyroidism is defined as TSH < 0.3 μIU/ml with normal FT_3 and FT_4 levels

RESULTS AND ANALYSIS

The present study titled **"Thyroid Profile in Type 2 Diabetes Mellitus"** was undertaken in the Department of Medicine and Department of Diabetology, kilpauk medical college and hospital(Chennai) over a period of 10 months from January 2009 to october 2009 .

The study sample included 108 type 2 diabetes patients in the wards and outpatient departments. Following were the observations:

Age Distribution of Cases

Table-1

Age Group (yrs)	No. of cases	Percentage
Upto 40	14	13.0
41-60	78	72.2
61 or more	16	14.8
Total	108	100.0

Distribution of Cases According to Sex

Table-2

Gender	No. of cases	Percentage
Male	44	40.7
Female	64	59.3
Total	108	100.0

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Distribution According to Duration of Diabetes Mellitus

Table-3

Duration of DM (in years)	**No. of cases**	**Percentage**
Up to 5 years	76	70.4
6-10 years	20	18.5
>10 years	12	11.1
Total	108	100.0

Distribution according to Type of treatment

Table-4

Distribution According to Regularity of treatment

Table-5

Regularity of treatment	No. of cases	Percentage
Regular	82	75.9
Irregular	20	18.5
Newly detected Diabetic patients	6	5.6
Total	108	100.0

Distribution according to Family history of Diabetes Mellitus

Table-6

Family h/o DM	No. of cases	Percentage
Yes	42	38.9
No	66	61.1
Total	108	100.0

Distribution of cases according to Systemic Hypertension

Table-7

Systemic Hypertension	No. of cases	Percentage
Yes	54	50.0
No	54	50.0
Total	108	100.0

Distribution of cases according to Coronary Artery Disease

Table-8

CAD	No. of cases	Percentage

Yes	12	11.1
No	96	88.9
Total	108	100.0

Distribution of cases according to Retinopathy

Table-9

Distribution of cases according to BMI

Table-10

BMI Group (Kg/m^2)	**No. of cases**	**Percentage**
< 18.5	2	1.9
18.5-22.9	42	38.9
23-29.9	48	44.4
≥ 30	16	14.8

Total	108	100.0

Among the study population, 59.2%(64/108) were overweight and obese; 38.9%(42/108) had normal BMI.

Distribution of cases according to HbA_{1C} level

Table-11

HbA_{1C} level	**No. of cases**	**Percentage**
≤ 6	2	1.9
6.1 - 8	50	46.3
> 8	56	51.9
Total	108	100

Among the study group, 56(51.9%) patients had HbA_{1C} level more than 8% and 52(48.2%) patients had 8 or less.

Distribution of cases according to Altered lipid profile

Table-12

Altered lipid profile	**No. of cases**	**Percentage**
TC	54	50%
LDL-C	78	84.24%
HDL-C	40	43.2%

TGL	54	50%

The above table shows that 50% (54/108) of the study group had raised total cholesterol level. 84.24%(78/108) had raised LDL-C level; 43.2% (40/108) had decreased HDL-C level and 50% (54/108) had hypertriglyceridemia.

Distribution of Cases according to Abnormal thyroid profile

Table-13

Thyroid Function	No.	Percentage
With normal thyroid profile	94	87.0
With abnormal thyroid profile	14	13.0
Total	108	100.0

The above table shows 13% (14/108) of the patients with diabetes mellitus in the study group had abnormal thyroid profile.

Distribution of thyroid diseases

Table-14

Thyroid profile	No.of cases	Percentage
Normal	94	87

Overt hypothyroidism	0	0
Subclinical hypothyroidism	12	11.1
Overt hyperthyroidism	0	0
Subclinical hyperthyroidism	2	1.9
Total	108	100

The above table shows that 11.1% (12/108) of the patients had report suggestive of sub clinical hypothyroidism and 1.9% (2/108) of the patients had report suggestive of sub clinical hyperthyroidism.

Abnormal thyroid profile Vs Age group

Table-15

Age group(yrs)		Abnormal thyroid profile		
		No	Yes	Total
Up to 40	count	12	2	14
	% within abnormal thyroid profile	12.8%	14.3%	13.0%
	% of total	11.1%	1.9%	13.0%
41 - 60	count	68	10	78
	% within abnormal thyroid profile	72.3%	71.4%	72.2%
	% of total	63.0%	9.3%	72.2%
>60	count	14	2	16
	% within abnormal thyroid profile	14.9%	14.3%	14.8%
	% of total	13.0%	1.9%	14.8%
Total	count	94	14	108
	% within abnormal thyroid profile	100.0%	100.0%	100.0%
	% of total	87.0%	13.0%	100.0%

P = 0.987 **Not significant**

Out of 14 patients with abnormal thyroid profile, 2 patients(14.3%) were found to be of age 61years and more, 10 (71.4%) were found to be of age between 41-60 years and 2(14.3%) were found to be 40 years or less. Compared with normal thyroid profile group it has no statistical significance.

Abnormal thyroid profile Vs Sex

Table-16

Sex		Abnormal thyroid profile		
		No	Yes	Total
Male	count	42	2	44
	%within abnormal thyroid profile	44.7%	14.3%	40.7%
	% of total	38.9%	1.9%	40.7%
Female	count	52	12	64
	%within abnormal thyroid profile	55.3%	85.7%	59.3%
	% of total	48.1%	11.1%	59.3%
Total	count	94	14	108
	%within abnormal thyroid profile	100.0%	100.0%	100.0%
	% of total	87.0%	13.0%	100.0%

P = 0.031 **Significant**

Out of 14 patients with abnormal thyroid profile, 14.3%(2) were males and 85.7%(12) were females. Compared with normal thyroid profile group, this is statistically significant .

Abnormal thyroid profile Vs Duration of Diabetes

Table-17

Duration (yrs)		Altered thyroid profile		
		No	Yes	Total
Up to 5	Count	70	6	76
	% within abnormal thyroid profile	74.5%	42.9%	70.4%
	% of total	64.8%	5.6%	70.4%
6 -10	Count	16	4	20
	%within abnormal thyroid profile	17.0%	28.6%	18.5%
	% of total	14.8%	3.7%	18.5%
>10	Count	8	4	12
	%within abnormal thyroid profile	8.5%	28.6%	11.1%
	% of total	7.4%	3.7%	11.1%
Total	Count	94	14	108
	%within abnormal thyroid profile	100.0%	100.0%	100.0%
	% of total	87.0%	13.0%	100.0%

p = 0.028 **Significant**

Among the 14 patients with abnormal thyroid profile, 28.65%(4) had Diabetes more than 10 years, 28.6%(4) had duration between 6-10 years and 42.9%(6) had Diabetes 5 years or less. Compared with normal thyroid group it is statistically significant.

Abnormal thyroid profile Vs Type of treatment

Table-18

P = 0.293 **Not Significant**

Out of 14 patients with thyroid abnormality, 57.1%(8) were on OHA, 14.3%(2) were on Insulin and the rest (28.6%) were on both OHA/Insulin. Compared with normal thyroid group it has no statistical significance .

Abnormal thyroid profile Vs Family history of Diabetes

Table-19

Family history of DM		Abnormal thyroid profile		
		No	**Yes**	**Total**
No	Count	66	0	66
	%within abnormal thyroid profile	70.2%	.0%	61.1%
	% of total	61.1%	.0%	61.1%
Yes	Count	28	14	42
	%within abnormal thyroid profile	29.8%	100.0%	38.9%
	% of total	25.9%	13.0%	38.9%
Total	Count	94	14	108
	%within abnormal thyroid profile	100.0%	100.0%	100.0%
	% of total	87.0%	13.0%	100.0%

P = 0.000 **Significant**

All patients with thyroid abnormality had family history of diabetes, but only 29.8%(28) of normal thyroid group had it. Statistically the difference is significant.

Abnormal thyroid profile Vs Hypertension

Table-20

P = 0.567 **Not Significant**

Out of 14 patients with abnormal thyroid profile, 57.1%(8) had Hypertension and the rest(42.9%) did not. Compared with patients with normal thyroid profile, it has no statistical significance.

Abnormal thyroid profile Vs Coronary artery disease

Table-21

CAD		Abnormal thyroid profile		
		No	Yes	Total
No	count	84	12	96
	% within abnormal thyroid profile	89.4%	85.7%	88.9%
	% of total	77.8%	11.1%	88.9%
Yes	count	10	2	12
	%within abnormal thyroid profile	10.6%	14.3%	11.1%
	% of total	9.3%	1.9%	11.1%
Total	count	94	14	108
	%within abnormal thyroid profile	100.0%	100.0%	100.0%
	% of total	87.0%	13.0%	100.0%

P = 0.685 **Not Significant**

Out of 14 patients with abnormal thyroid profile, 14.3%(2) had CAD and rest(85.7%) had no CAD. Compared with normal thyroid profile group this is not statistically significant.

Table-22 : Abnormal Thyroid Profile Vs BMI

p = 0.158 **Not significant**

Out of 14 persons with abnormal thyroid profile, 71.5%(10) were overweight and obese. Compared with normal thyroid profile group this is not statistically significant.

Abnormal Thyroid Profile Vs HbA_{1C} Level

Table-23

HbA_{1C} (%)		Abnormal thyroid profile		
		No	**Yes**	**Total**
≤ 6	count	2	0	2
	% within abnormal thyroid profile	2.1%	.0%	1.9%
	% of total	1.9%	.0%	1.9%
6.1 - 8	count	44	6	50
	% within abnormal thyroid profile	46.8%	42.9%	46.3%
	% of total	40.7%	5.6%	46.3%
>8	count	48	8	56
	% within abnormal thyroid profile	51.1%	57.1%	51.9%
	% of total	44.4%	7.4%	51.9%
Total	count	94	14	108
	% within abnormal thyroid profile	100.0%	100.0%	100.0%
	% of total	87.0%	13.0%	100.0%

p=0.268 **Not significant**

Out of 14 patients with altered thyroid profile, 57.1%(8) had HbA_{1C} value above 8% and the remaining(42.9%) had HbA_{1C} 8 or less. Compared with normal thyroid profile group this is not statistically significant .

Abnormal Thyroid Profile Vs Total cholesterol

Table-24

Abnormal thyroid profile	No.	Mean	Std. Deviation	Std. Error of Mean
Yes	14	230.49	89.852	24.014
No	94	201.7	52.098	5.374

p = 0.08 **Not significant**

The mean total cholesterol level of patients with abnormal thyroid profile was 230.49 mg/dl and for the normal thyroid group was 201.7 mg/dl. Comparing the two groups, the difference is statistically insignificant.

Abnormal Thyroid Profile Vs LDL cholesterol

Table-25

p = 0.088 **Not significant**

The mean LDL- C level of patients with abnormal thyroid profile was 137.34 mg/dl and that of normal thyroid group was 118.7 mg/dl. Comparing the two groups the difference is statistically not significant.

Abnormal Thyroid Profile Vs HDL cholesterol

Table-26

p = 0.155 **Not significant**

The mean HDL- C level of patients with abnormal thyroid profile was 51.44 mg/dl and that of normal thyroid group was 46.14 mg/dl. Comparing the two groups the difference is statistically not significant.

Abnormal Thyroid Profile Vs Triglyceride

Table-27

p = 0.524 **Not significant**

The mean Triglyceride level of patients with abnormal thyroid profile was 211.66 mg/dl and that of normal thyroid group was 186.89 mg/dl. Comparing the two groups the difference is statistically not significant.

BINARY LOGISTIC REGRESSION

- Binary logistic regression model was used to identify the risk factors associated with abnormal thyroid profile in diabetic population.
- The dependent variable is Abnormal thyroid profile.
- The independent variables tested are Sex, Duration of diabetes mellitus and Family history of diabetes mellitus.

The analysis report showed significant correlation between altered thyroid profile and the female gender.

DISCUSSION

Diabetes mellitus is the most common endocrine disorder which involves multiple organ systems and leads to significant morbidity and mortality due to accompanying complications. Thyroid diseases are also a common endocrinopathy seen in the adult population. Thyroid hormones are intimately involved in cellular metabolism. Thus excess or deficit of either insulin or thyroid hormone could result in the functional derangement of the cellular metabolism.

In the present study patients of diabetes mellitus were taken from Medical and Diabetic Outpatient Departments, Male & Female medical wards of kilpauk medical college and hospital(Chennai) over a period of 10 months from January 2009 to october 2009 and they were evaluated for altered thyroid profile.

AGE DISTRIBUTION

In the present study of 108 type 2 diabetic patients, , 14 patients (13%) were up to 40 years, , 78 patients (72.2%) were between 41-60 years and 16 patients (14.8%) were 61 years or more. This shows that the disease was more prevalent between 41-60 years of age.

This observation was similar to WHO report which predicts that while the

main increase in diabetes would be in the > 65 year age group in the developed countries, in India and developing countries the highest increase would occur in the age group of 45-65 year of age group.[65] This observation is also similar to Kapur et al , who reported that maximum number of cases were diagnosed between 40 and 59 year of age with no significant difference between the genders.[66]

GENDER DISTRIBUTION

In the present study 40.7%(44 nos) of the studied population were males and 59.3%(64 nos) were females. Female to male ratio was 1.45:1.

This observation was similar to Arthur M. Michalek et al who reported that prevalence of diabetes among women was higher than in men.[67]This is in contrast to Jali et al[68] and Flatau E et al[69] who reported that diabetes was more prevalent in men than in women.

Sample size in our study is too small. This might have affected the results.

DURATION OF DIABETES MELLITUS

In the present study, majority of cases that is 70.4% (76/108) had duration of diabetes up to 5 years, 18.5% (20/108) of patients had duration between 6-10 years and 11.1% (120108) of patients had duration of illness more than 10

years.Majority of people are in the age group between 41 to 60 yrs and have duration of disease less than 5 years.

CO-MORBID DISEASES

In the present study, 50%(54/108) of the studied population had hypertension. L Tanow observed that 78% of IDDM patients and 50% of NIDDM had hypertension.[70] Fuller H et al observed that the frequency of WHO defined hypertension was highest in NIDDM patients older than 53 years, being 43% of male and 52% of females.[71] Both these studies support our findings.

Prevalence of CAD in general population in urban areas in India is 6.4%[72]. In the present study, 11.1% (12/108) of patients had Coronary Artery Disease almost twice that of in general population. This is supported by two studies which concluded that Type 2 diabetes increases relative risk of cardiovascular disease two- to fourfold compared with the risk in the general population.[73,74]

FAMILY HISTORY OF DIABETES MELLITUS

In the present study, 38.9% (42nos) of patients had family history of Diabetes and the remaining 61.1% (66nos) had no family history.

This study is similar to that of Tattersal and Fojans[75] and Vishwanthan[76] .Vishwanthan et al conducted a study among 107 subjects. Out of 73 subjects

who gave positive family history diabetes, 19 subjects (26%) later developed diabetes.

REGULARITY OF TREATMENT

In the present study, Out of 108 subjects of the study group, 6(5.6%) were newly detected Diabetic patients. In the remaining , 75.9% (82/108) were on regular treatment and 18.5% (20/108) were irregular .

Asha et al observed that 97% of type 2 diabetics were on antidiabetic agents and most were using them irregularly.[77] Kaur et al observed that oral anti diabetic drug compliance rate was 62.9% in diabetic population.[78] The difference in our study may be due to small sample size.

BMI

Among the study population, 59.2%(64/108) were overweight and obese; 38.9%(42/108) had normal BMI.

Mc Larty et al reported that prevalence of IGT in subjects of all age group increased with rising BMI.[79] Yon Gik et al reported that the prevalence of diabetes mellitus and IGT increased with rising BMI and with increase in

WHR.[80] Both these studies support our findings.

RETINOPATHY

In the present study, 24.1% (26/108) patients had diabetic retinopathy and rest 75.9% (82/108) had no retinopathy. This study was almost similar to that of Marianne etal who observed that the prevalence of diabetic retinopathy in type 2 diabetes mellitus was 31.5%[81] and that of A.Southwell et a who found that prevalence of diabetic retinopathy was 15%.[82]

DYSLIPIDEMIA

In the present study, 50% (54/108) of the study group had raised total cholesterol level; 84.24%(78/108) had raised LDL-C level; 43.2% (40/108) had decreased HDL-C level and 50% (54/108) had hypertriglyceridemia. This shows that the incidence of dyslipidemia is high in diabetics.

Liao et al reported that patients who had diabetic glycaemic tolerance had more of intra-abdominal fat , higher triglyceride levels, lower HDL cholesterol levels and higher blood pressure than those with Normal glucose tolerance.[83] A.Southwell et al in their study found that 40% of the diabetics had hypercholesterolaemia.[82]

HBA_{1C} LEVEL

In the present study, 51.9%(56nos) had HbA_{1C} level more than 8% and

48.1% (52nos) had level HbA_{1C} less than 8%. More than half of the diabetics had poor glycemic control. Paolo fumelli in his study of 562 diabetic patients found that all the patients had level HbA_{1C} greater than 8%.[84]

ABNORMAL THYROID PROFILE

In the present study, 13% (14) of the total 108 patients with diabetes mellitus had abnormal thyroid profile.

The present study is similar to Abdel-Rahman et al who in his study of 908 type 2 diabetic patients found that the prevalence of thyroid disease was 12.5%, 6.6% of whom were newly diagnosed and 5.9% had known thyroid dysfunction. The prevalence of thyroid disease in the non diabetic control group was 6.6%.[59] Chubb et al in a cross-sectional study of 420 patients with type 2 diabetes mellitus found that 8.6% of patients had subclinical hypothyroidism.[64]

Smithson M J in his study found that the prevalence of thyroid disease in the entire population of diabetic patients registered in the general practice was 10.8%. In the control group of non diabetics, the prevalence was 6.6%.[61] D.H.akbar et al in their study of 100 type 2 diabetics found that the prevalence of thyroid dysfunction was 16% and in control groupof non diabetics, it was 7%.[85]

Zdrojewicz et al in their study of 75 diabetic patients found that there was no differences in thyroid gland function between patients with type 2 diabetes mellitus and non diabetics. This study contradicts our findings.[62]

DISTRIBUTION OF THYROID ABNORMALITIES

In the present study, 11.1% (12) of the patients had report suggestive of sub clinical hypothyroidism and 1.9% (2) of the patients had report suggestive of sub clinical hyperthyroidism.

This study was similar to Abdel-Rahman et al who in their study of 908 type 2 diabetic patients found that 10.3% of patients had hypothyroidism (overt and sub clinical) and 1.7% of patients had hyperthyroidism (overt and sub clinical).[59] Smithson et al in their study of 233 diabetes mellitus patients found that 11 patients were found to have undiagnosed thyroid disease, out of which 9 were having hypothyroidism (overt and sub clinical) and 2 were having hyperthyroidism (overt and sub clinical).[61]

Celani MF et al in their study of 290 type 2 diabetes mellitus patients found that 91 patients(31.4%) had abnormal TSH concentrations out of which

48.3% had subclinical hypothyroidism, 24.2% had subclinicl hyperthyroidism, 23.1% had overt hypothyroidism and 4.4% had overt hyperthyroidism.[55]

In the present study, diabetic patients, when compared with the control group of normal patients in Whickham Study[86] and a 20 years follow-up of whickham survey by Vanderpump MP et al[87] shows that the prevalence of altered thyroid profile in the study group is significant (p=0.0064).

The presence of altered thyroid profile in diabetic patients may be due to the fact that:

- In euthyroid individuals with diabetes mellitus, the serum T_3 levels, basal TSH levels and TSH response to thyrotropin releasing hormone (TRH) may all be strongly influenced by the glycemic status.[41]
- Poorly controlled diabetes may also result in impaired TSH response to TRH or loss of normal nocturnal TSH peak.[43]
- It may be related to older age of the type 2 DM patients.[64]

SIGNIFICANCE OF AGE IN PATIENTS WITH ABNORMAL THYROID PROFILE

Among the patients with abnormal thyroid profile, each 14.35% (2/14) of

patients were found to be of age 61 and more and 40 or less. 71.4% (10/12) were found to be of age between 41-60 years. Though there is difference, when Compared between patients with normal and abnormal thyroid profile it has no significance (p=0.987)

The present study findings contradict with that of Chubb et al who in their study found that age and anti – TPO status correlates with altered thyroid profile in diabetic patients.[64]

Vondra et al in his study found that thyroid diseases in diabetic patients is 2-3 times higher than in nondiabetic subjects; it raises with age, and is strongly influenced by female gender and autoimmune diabetes. This also contradicts with our findings.[58]

ANALYSIS OF SEX DISTRIBUTION IN CASES WITH ABNORMAL THYROID PROFILE

In the present study 85.7%(12/14) patients were found to be female compared to 14.3% (2/12) male in the group with abnormal thyroid profile. Compared between patients with normal and abnormal thyroid profile this is

statistically significant (p=0.031).

Celani MF et al, Arthur M. Michalek et al and Abdel-Rahman et al in their study found that the prevalence of thyroid dysfunction was significantly higher in the female than in the male diabetic patients.[55,67,59]

Also Vondra et al and Cardoso et al found significant correlation between female gender and altered thyroid profile.[58,88]

SIGNIFICANCE OF TYPE OF TREATMENT IN PATIENTS WITH ABNORMAL THYROID PROFILE

Out of 14 patients with thyroid abnormality, 57.1%(8/14) were on OHA, 14.3%(2/14) were on Insulin and 28.6%(4/14) were on both OHA/Insulin. Compared with normal thyroid profile group it has no statistical significance (p=0.293)

The findings of our study are similar with Chubb et al , who in their study found that altered thyroid profile was associated with anti – TPO status and age, but there was no independent associations with serum cholesterol, history of coronary heart disease, SHT, HbA_{1C} or hypoglycaemic therapy.[64] Celani MF et al in their study found that the prevalence of abnormal thyroid function test results was significantly higher in insulin treated patients than in those receiving OHA. This contradicts with our study.[55]

SIGNIFICANCE OF ASSOCIATED SHT AND CAD IN PATIENTS WITH ABNORMAL THYROID PROFILE

In the present study, 57.1%(8/14) of patients had hypertension in the group of 14 patients with abnormal thyroid profile whereas 42.9% (6 /14) of patients had no hypertension. This finding has no statistical significance (p=0.567).

14.3% (2/14) were found to have CAD compared to 85.7% (12/14) without CAD in patients with abnormal thyroid profile. Compared between patients with normal and abnormal thyroid profile this finding was found to be insignificant (p=0.685).

The findings of our study are similar with Chubb et al who in their study found that there was no independent association of altered thyroid profile with history of coronary heart disease and SHT.[64] Muñoz Núñez et al in a study of 48 compensated diabetic patients, found that there is a decrease of T_3 in all diabetic patients, this being more noticeable in diabetic females and diabetic patients with vascular disease.[89] This contradicts with our study.

ANALYSIS OF BMI IN CASES WITH NORMAL AND ABNORMAL THYROID PROFILE

Out of 14 patients with abnormal thyroid profile, 42.9%(6/14) were overweight and 28.6%(4/14) were obese. The mean BMI of the patients with altered thyroid profile was 27.30 Kg/m^2 compared to 25.25 Kg/m^2 in patients with normal thyroid profile. There was no significant correlation between BMI and abnormal thyroid profile(p=0.158).

Fan W et al observed in their study that obese individuals have normal levels of thyroxine(T4) and thyroid stimulating hormone(TSH) but, increased levels of triiodothyronin(T_3) in a minority of subjects.[90]

The findings contradict with Process et al who in their study found that besides known parameters such as age and drugs, thyroid-function tests can also be altered by diabetes mellitus and obesity.[55]

ANALYSIS OF HbA_{1C} LEVEL IN CASES WITH NORMAL AND ABNORMAL THYROID PROFILE

Out of 14 patients with abnormal thyroid profile, 57.1%(8/14) had HbA_{1C} value above 8% and the remaining(42.9%) had HbA_{1C} 8 or less. The mean HbA_{1C} level of the patients with abnormal thyroid profile was 9.29% compared to 8.67% in the patients with normal thyroid profile. This difference is not statistically significant(p=0.268).

The findings are similar to the studies by Parr JH et al and Chubb et al who

found no correlation between changes in free thyroid hormone concentrations and HbA_{1C} level.[63,64]

Celani MF et al in their study in 91diabetic patients with altered thyroid profile found that TSH level in serum decreased in subclinical hypothyroidism and increased in subclinical hyperthyroidism with significant fall in HbA_{1C} level. This contradicts with our findings.

ANALYSIS OF SERUM LIPID PROFILE IN CASES WITH NORMAL AND ABNORMAL THYROID PROFILE

Comparing the two groups the differences were not statistically significant.

S.A.P.Chubb et al in their substudy of Fremantle diabetes study found that there were strong association between TSH and lipid parameters with adverse cardiac risks at low insulin sensitivity that were absent at higher insulin sensitivity.[64]

Bakker SJL et al also concluded the same in their study in non diabetic individuals with insulin resistance.[91] Both these studies contradict our findings.

Our study found that the prevalence of thyroid disease in diabetic population is more when compared to non diabetic patients.

Age, duration of diabetes, type of treatment, history of hypertension or CAD, BMI, HbA_{1C} level and serum lipidprofile has no correlation with thyroid profile in type 2 diabetes mellitus but there is significant correlation between female gender and abnormal thyroid profile.

SUMMARY

This study aimed at estimating the prevalence of thyroid dysfunction in type 2 Diabetes mellitus patients and also to find out it's correlation with various risk factors.

The study sample included 108 type 2 diabetic patients presented in the wards and outpatients department. Each patient was assessed clinically and by laboratory investigations.

Primary observations regarding thyroid profile in patients with type 2 diabetes mellitus

- In the present study, 13%(14 nos) of patients with type 2 diabetes mellitus had abnormal thyroid profile.
- In patients with abnormal thyroid profile(14nos), most common abnormality was subclinical hypothyroidism(85.7%) followed by subclinical hyperthyroidism(14.3%).
- Our study showed significant correlation between abnormal thyroid profile and gender, duration of diabetes and family history of diabetes. Binary logistic regression model analysis showed significant association only with female gender.

- In persons with abnormal thyroid profile, 85.7% were females and 14.3% were males.This is statistically significant. The prevalence of thyroid abnormalities is more common in females than in males.
- No significant correlation was found between altered thyroid profile and age, type of treatment, SHT, CAD, BMI, HbA_{1C} level and serum lipid profile.

Additional observations in the study group of type 2 diabetes mellitus subjects:

- In the present study, patients ranged from 36 to 70 years of age. Maximum number of patients were in the age group between 41 to 60yrs (72.2%).
- Majority (70.4%) of patients were on OHA and 14.8% each were on insulin and both OHA/Insulin.
- Majority(75.9%) of patients were on regular treatment and 18.5% were irregular.
- 30.9% patients were having family history of diabetes mellitus and 61.1% had no family history.
- The prevalence of SHT (50%) and CAD (11.1%) were higher among diabetic population.
- Significant number of patients (24.1%) had diabetic retinopathy.

- Majority (59.2%) of the diabetic patients were overweight and obese.
- 51.9% had HbA_{1C} level more than 8% and 48.1% had HbA_{1C} level less than 8% showing that more than half of the patiens had poor glycaemic control.
- 50% of the patients had raised total cholesterol level, 84.24% had raised LDL cholesterol level, 43.25% had decreased HDL cholesterol level and 50% had raised Triglyceride level showing that majority of diabetics have dyslipidemia.

CONCLUSION

- Prevalence of thyroid dysfunction is more common among type 2 diabetes mellitus patients than in general population.
- Prevalence of thyroid dysfunction in patients with type 2 diabetes mellitus is higher in females than in males
- There is no significant correlation between Age, Duration of diabetes, Family history of diabetes, type of treatment, SHT, CAD, BMI, HbA_{1C} level and serum lipid profile.
- Routine screening for thyroid dysfunction in type 2 diabetes mellitus patients may be justified especially in females because the progression to overt thyroid dysfunction is associated with significant morbidity including the adverse effects on glycemic control, lipid profile, bone mineral density and cardiovascular events.

LIMITATIONS

- Study population was small.
- Associated thyroid autoimmunity was not evaluated due to constraints. So it was not able to refine the spectrum of thyroid dysfunction in type 2 diabetics.
- Follow up study was not done. So the natural history of subclinical thyroid dysfunction and it's effect on various parameters could not be assessed.

BIBLIOGRAPHY

1. Peter H Bennett, William C Knowlap. Definition, diagnosis and classification of diabetes. Joslin's diabetes mellitus 14th edition,2005: 331-337.
2. Alvin C .Powers. Diabetes mellitus. Harrison's principles of internal medicine 17th edition,2008: 2275-2304.
3. IDF Diabetes atlas 4th edition, 2009.
4. WHO(2003), Tech. Rep. Ser., N 916.
5. WHO(2002), Health situation in the South East Asia Region 1998-2000, New Delhi.
6. International Diabetes Federation, 20th October 2009, Montreal.
7. UN. 83rd plenary meeting, 20th December 2006. 61st session; Agenda 113.
8. Donald M Barnett, Leo P. Krall. History of diabetes. Joslin's diabetes mellitus 14th edition,2005: 1-17.
9. Porter R. The greatest benefit to mankind, al medical history of humanity. New York: WW Norton, 1997:71.
10. Schadewaldt H. The history of diabetes mellitus. In: Van Englehardt D, ed. Diabetes, its medical and cultural history. Berlin: Springer Verlag, 1987:43–100.
11. Langerhans P. Beitrage zur mikroskopischen Anatomie der Bauchspeicheldruse. Med Diss (Berlin), 1869.
12. Morrison H. Translation and introductory essay. Langerhans P. Contributions to the microscopic anatomy of the pancreas. Bull Inst Hist Med 1937;5:259–269.
13. Minkowski O. Historical development of the theory of pancreatic diabetes (introduction and translation by R. Levine). *Diabetes* 1989;38:1–6.

14. De Meyer J. Contribution à l'étude de la pathogénie du diabete pancréatique. Archive Internationale de Physiologie 1909:121–180.
15. Banting FG, Best CH. The internal secretion of the pancreas. J Lab Clin Med 1922;7:251–266.
16. Savage PJ, Bennion LJ, Bennett PH. Normalization of insulin and glucagon secretion in ketosis-resistant diabetes mellitus with prolonged diet therapy. J Clin Endocrinol Metab 1979;49:830–833.
17. Agner T, Damm P, Binder C. Remission in IDDM: prospective study of basal C-peptide and insulin dose in 268 consecutive patients. Diabetes Care *1987;10:164–169.*
18. Gavin JR III, Alberti KGMM, Davidson MB, et al. Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. Diabetes Care 1997;20:1183–1197
19. WHO Consultation Group. Definition, diagnosis and classification of diabetes mellitus and its complications, 2nd ed. Part 1: Diagnosis and classification of diabetes mellitus WHO/NCD/NCS/99. Geneva: World Health Organisation, 1999:1–59.
20. Turner RC, Cull CA, Frighi V, et al. Glycemic control with diet, sulfonylurea, metformin, or insulin in patients with type 2 diabetes mellitus: progressive requirement for multiple therapies (UKPDS 49). UK Prospective Diabetes Study (UKPDS) Group. *JAMA* 1999;281:2005–2012.
21. Dabelea D, Pettitt DJ, Jones KL, et al. Type 2 diabetes mellitus in minority children and adolescents. An emerging problem. Endocrinol Metab Clin North Am 1999;28: 709-29.
22. American Diabetes Association 2007, Criteria for the diagnosis of

diabetes mellitus. Diabetes care, Volume 30, Supplement 1, January 2007.

23. Howard BV. Pathogenesis of diabetic dyslipidemia. Diabetes Rev 1995;3:423–432.
24. Siegel RD, Cupples A, Schaefer EJ, et al. Lipoproteins, apolipoproteins, and low-density lipoprotein size among diabetics in the Framingham offspring study. *Metabolism* 1996;45:1267–1272.
25. Robert H. Eckel. The metabolic Syndrome. Harrison's principles of internal medicine 17th edition,2008:1509-1514.
26. Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. Executive Summary of the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). *JAMA* 2001;285:2486–2497.
27. J,Larry Jameson, Anthony P. Weetman. Disorders of thyroid gland. Harrison's principles of internal medicine 17th edition,2008: 2224-2247.
28. Thyroid and Antithyroid drugs. Katzung Basic clinical pharmacology 10th edition,2007: 618-634.
29. Physiological effects of thyroid hormones. William F. Ganong Review of medical physiology 22nd edition: 317-332.
30. P.Reed Lorson, F. Davies. Quantitation of serum thyroid hormone concentration. Williams textbook of Endocrinology 11th edition: 299-332.
31. Nikhil Tandon. API Text book of medicine 8th edition:1002-1010
32. Chidakel A, Mentuccia D, Celi FS: Peripheral metabolism of thyroid hormone and glucose homeostasis. *Thyroid* 2005; 15:899-903.
33. Gregory A. Brent, P. Reed Larsen, Terry F. Davies.

Hypothyroidism and thyroiditis. Williams textbook of Endocrinology 11th edition: 377-409.

34. Huber G, Staub J-J, Meier C, et al: Prospective study of the spontaneous course of subclinical hypothyroidism: prognostic value of thyrotropin, thyroid reserve, and thyroid antibodies. *J Clin Endocrinol Metab* 2002; 87:3221-3226
35. Kvetny J, Heldgaard PE, Bladbjerg EM, et al: Subclinical hypothyroidism is associated with a low-grade inflammation, increased triglyceride levels and predicts cardiovascular disease in males below 50 years. *Clin Endocrinol (Oxf.)* 2004; 61: 232-238
36. Cappola AR, Fried LP, Arnold AM, et al: Thyroid status, cardiovascular risk, and mortality in older adults. *JAMA* 2006; 295:1033-1041.
37. F. Davies, P.Reed Lorson. Thyrotoxicosis. Williams textbook of Endocrinology 11th edition: 333-368.
38. Silva JE: The thermogenic effect of thyroid hormone and its clinical implications. *Ann Intern Med* 2003; 139:205-213.
39. Faber J, Galloe AM: Changes in bone mass during prolonged subclinical hyperthyroidism due to L-thyroxine treatment: a meta-analysis. *Eur J Endocrinol* 1994; 130:350-356.
40. R. Sathish,V. Mohan. Diabetes and Thyroid disease-A Review. Int J of Diabetes in Developing countries 2003;23; 120-123.
41. Schlienger JL, Anceau A, Chabrier G, North ML,. Stephan F. Effect of diabetic control on the level of circulating thyroid hormones. Diabetologia. 1982;22;486-8
42. Donckier JE. Endocrine diseases and diabetes. In: Textbook of Diabetes mellitus. Pickup JC, Williams G (eds), Blackwell Publishing Company, Chichester, 2003: 27.1– 27.25.
43. Coiro V, Volpi R, Marchesi C, et al. Influence of residual C-peptide secretion on nocturnal serum TSH peak in well-controlled diabetic

patients. Clin. Endocrinal. 1997;47:305-10.

44. Kalmann R, Mourits M. Diabetes Mellitus: a risk factor in patients with Grave's orbitopathy. Br. J. Ophthalmol. 1999; 83: 463-465.

45. Taylor R, Muculloch A, Zeuzem S, Gray P, Clark F, Alberti G. Insulin secretion, adipocyte insulin binding and insulin sensitivity in thyrotoxicosis. Acta Endorcinol. 1985;109:96-103.

46. Ahren B, Lundquist I, Hedner P, Valdemassan S, Scheroten B. Glucose tolerance and insulin and C-peptide responses after various insulin secretions stimuli in hyperthyroid and hypothyroid subjects before and after treatment diab. Res. Clin. Practice. 1985;2:95-103.

47. Randin J, Tappy L, Scazziga B, Jequier E, Felber J. Insulin sensitivity and exogenous insulin clearance in Grave's disease. Measurements by the glucose clamp technique and continuous glucose calorimetry. Diabetes. 1986;35:178-81.

48. Bech K, Damsbo P, Eldrup E, et al. Beta cell function and glucose and lipid oxidation in Grave's disease. Clin. Endocrinol. 1996;44: 59-66.

49. Dimitriadis G, Raptis S A. Thyroid hormone excess and glucose intolerance. Exp Clin. Endocrinol. Diabetes. 2001; 109: S225-S239.

50. Holness M, Sugden M. Continued glucose output after refeeding contributes to glucose intolerance in thyroid disease. Biochem. J. 1987;247:801-4.

51. Mokuno T, Uchimura K, Hayashi R, et al. Glucose transporter concentration in hyper and hypothyroid rat livers. J. Endocrinol. 1999;160:285-9.

52. Haber R, Wilson C, Weinstein S, Pritsker A, Cushman S. Thyriod hormone increases the partitioning of glucose transporters to the plasma membrane in ARL 15 cells. Amer. J. Physiol. 1995;269:E605-E610.

53. Dimitriadis G. Parry-Billings M, Bevan S, et al. The effects of insulin on transport and metabolism of glucose in skeletal muscle from hyperthyroid

and hypothyroid rats. Eur. J. Clinical. Invest. 1997;27:475-83.

54. Mohn A, Di Michele S, Di Luzio R, Tumini S, Chiarelli F. The effect of sub clinical hypothyroidism on metabolic control in children and adolescents with type 1 diabetes mellitus. Diab. Med. 2002;19:70-3.
55. Celani MF, Bonati ME, Stucci N. Prevalence of abnormal thyrotropin concentrations measured by a sensitive assay in patients with Type 2 diabetes mellitus. Diabetes Res 1994; 27: 15-25.
56. Proces S, Delgrange E,Vander Borght TV, Jamart J, Donckier JE. Minor alterations in thyroid-function tests associated with diabetes mellitus and obesity in outpatients without known thyroid illness. Acta Clin Belg. 2001 Mar-Apr; 56(2):86-90.
57. Roderick E. Warren, Petros Perros, Moffat J. Nyirenda, Brian M. Frier. Serum Thyrotropin is a better predictor of future thyroid Dysfunction than Thyroid Autoantibody status in biochemically euthyroid patients with Diabetes: Implications for Screening. Thyroid. 2004, 14(10): 853-857.
58. Vondra K, Vrbikova J, Dyorakova K. Thyroid gland diseases in adult patients with diabetes mellitus. Minerva Endocrinol. 2005 Dec;30(4):217-36
59. Abdel Rahman, Nusier MK, Amari FL et al. Thyroid dysfunction in patients with type 2 diabetes mellitus in Jordan. Saudi Med J. 2004 Aug;25(8):1046-50.
60. Perros P, Mc Crimmon RJ, Shaw G, Frier BM, Frequency of thyroid dysfunction in diabetic patients, value of annual screening. Diabet Med 1995;12:622-627.
61. Smithson MJ. Screening for thyroid dysfunction in a community population of diabetic patients. Diabet Med 1998; 15 (2): 148-50.
62. Zdrojewicz Z, Humpich G, Januszewski A, Adamek J. The assessment of thyroid gland function in patients with non-insulin dependent diabetes mellitus(type 2). Wiad Lek.1999;52(1-2): 35-41.

63. Parr JH. The effect of long-term metabolic control on free thyroid hormone levels in diabetics during insulin treatment. Ann Clin Biochem. 1987 Sep; 24 (Pt 5):466-9.
64. Chubb SA, Davis WA, Inman Z, Davis DME.Prevalence and progression of subclinical hypothyroidism in women with type 2 diabetes: the Fremantle Diabetes Study. Clin Endocrinol (Oxf). 2005 Apr;62(4):480-6.
65. Wild S, Rogli G, Green A. Global prevalence of diabetes estimates for the year 2000 and projection for 2030. Diabetes Care, 2004; 27: 1047-53.
66. Kapur A., Snehlatha C., Ramchandran A., Vijay V., Mohan V., Das A.K., Rao P.V., Yajnik C.S., Prasanna Kumar K.M., Jyotsna Nair: High prevalence of diabetes and impaired glucose tolerance in India. National Urban diabetes survey. Diabetologia 2001; Vol. 44: 1094 –1101.
67. Arthur M.Michalek, Martin C.Mahoney, Donald Calebaugh: Hypothyroidism and Diabetes Mellitus in an American Indian Population. Journal of family practice 2000 July; 49:638-640.
68. Jali MV, Mohan V, Ramchandran A, Snehlatha C and Viswanathan M; High Prevalence of diabetes in an Urban population in South India. BMJ Sept 1988; Vol. 297: p- 587-590.
69. Flatau E.; Trougouboff P.; Kaufman N.; Reichman N.; Luboshitzky R. Prevalence of hypothyroidism and diabetes mellitus in elderly kibbutz members. European Journal of Epidemiology, Volume 16, Number 1, January 2000 , pp. 43-46(4).
70. Tanow L, Ressing P, Gall MA, Neelson FS. Prevalence of arterial hypertension in diabetic patients before and after JNC V. Diabetes Care 1994:Vol. 17, Issue 11: 1247-1251.
71. Fuller H, Stevens LK. Prevlence of hypertension among diabetic patients & its relation to vascular risk. Diabetes Hypertension Study Group. J Hum Hypertens. August 1991; 5(4): 237-43.
72. Assesment of burden of non communicable diseases, Final report.

ICMR,2004.

73. Kannel WB, McGee DL. Diabetes and cardiovascular disease. The Framingham Study. *JAMA* 1979;241:2035-38.
74. Jarrett RJ, McCartney P, Keen H. The Bedford survey: ten year mortality rates in newly diagnosed diabetics, borderline diabetics and normoglycaemic controls and risk indices for coronary heart disease in borderline diabetics. *Diabetologia* 1982;22:79–84.
75. Tattersal R.B., Fojans S, Arbor A: Prevalence of Diabetes and Glucose Intolerance in offsprings of 37 conjugal Diabetic parents. Diabetes 1975, 24:452-462.
76. Vishwanthan M, Mohan V, Snehlatha C, Ramchandran A: High prevalence of type 2 Diabetes among the offspring of conjugal type 2 parents in India. Diabetologia, 1985, 28:907-910.
77. Asha A, Pradeepa R, Mohan V. Evidence for Benefits from diabetes education program. Int J Diab Dev Countries 2004; 24:96-102(4).
78. Kaur K, Singh MM, Kumar, Walia I. Knowledge and self-care practices of diabetics in a resettlement colony of Chandigarh. Indian J Med Sci. 1998;52:341-7.
79. Mc Larty DG, Kitange, Chuwa LM: Prevalence of Diabetes and impaired glucose tolerance in rural Tanzania 1989, 22: 871-74.
80. Yon Gik Kim, Youngsoo Shin, Younsoo Park. Prevalence of Diabetes and impaired glucose tolerance in Yonchon country, South Lorea, Diabetic care 1994, 545-48.
81. Marianne Hove, Jatti K. Kristensen, Torsken Launtzen and Toke Befe. Prevalence of retinopathy in an unselected population of Type 2 diabetes mellitus , Denmark. Acta Ophthalmologica Scandinavica. August, 2004; Vol. 82 Issue 4: 443.
82. A.Southwell, D. Eckland. Managing the burden of type 2 diabetes: an

international survey of physicians. Practical Diabetes Int. 2005;14:201-206.

83. Liao, Shofer: Abnormal glucose tolerance and increased risk for cardiovascular disease in Japanese Americans. Diabetic care. 2001, 24 (1):39-44.

84. Paolo Fumelli, Silvia Natalucci, Massimo Boemi. One and two compartment minimal models detect similar alterations of glucose metabolism indexes in hypertension. Metabolism.Volume 49;12: 1529-1536

85. D.H.Akbar, M.M.Ahmed, J. Al-Mughales. Thyroid dysfunction and thyroid autoimmunity in Saudi type 2 diabetics. Acta Diabetol(2006).43;14-18.

86. Tunbridge WMG, Evered DC and Hall R et al; The spectrum of thyroid disease in a community. The Whickham survey. Clin. Endocrinol(oxf) 1977: 7: 481-93.

87. Vanderpump MP, Tunbridge WM, Frence JM, Appleton D, Bates D, Clark F, et al. Thee incidence of thyroid disorders in the community: a twenty year follow up of whickham survey. J Clin Endocrinol 1995;43(1):55-68.

88. Cardoso C, Ohwovoriole AE, Kuku SF. J Diabetes. A study of thyroid function and prevalence of thyroid auto antibodies in an African diabetic population. J Diabetes Complications 1995; 9:37-41.

89. Muñoz Núñez A, González Sarmiento E, Ergueta Martín P, Escorial Miguel C, Crespo Pinilla J, Marañón Cabello A. Thyroid function study in patients with diabetes mellitus. An Med Interna. 1990 Jun;7(6):291-3.

90. Fan W, Dinulescu DM, Butler AA, et al. The central melanocortin system can directly regulate serum insulin levels. Endocrinology 2000;141:3072–3079

91. Bakker SJL, Ter Maaten JC, Slates JPJ, Heine RJ. The relationship

between TSH and LDL cholesterol is modified by insulin sensitivity in healthy euthyroid subjects, J Clin Endocrinol Metab 2001; 86:1206-1211.

RECOMMENDATIONS

- Biochemical tests of thyroid functions are readily available and relatively inexpensive. So, a baseline thyroid function test to be done in all type 2 dibetic patients at first visit especially in females.
- Longitudinal studies are needed to find out the incidence of thyroid dysfunction in type 2 diabetes mellitus patients and to determine the need of regular screening for thyroid dysfunction during follow up and it's cost effectiveness.
- Follow up thyroid function test to be done to assess the progression of subclinical thyroid dysfunction in type 2 diabetics because of associated morbidity of overt thyroid dysfunction in these patients.

DEPARTMENT OF MEDICINE

Kilpauk medical college and hospital,chennai

PROFORMA

STUDY OF THYROID PROFILE IN TYPE 2 DIABETES MELLITUS

S.No. Reg. No. (OPD/Ward)

Name: Age/Sex

Address:

Occupation Religion SES

Presenting Complaints:

Tiredness	Dry Skin	muscle cramps
Decreased sweating	Insomnia	
Somnolence		
Poor Appetite	Myalgia/Arthralgia	
Weight Gain/Weight Loss	Breathlessness	
Cold Intolerance	Swollen Limb	
Constipation	Paresthesia	
Change in Voice	Impaired Hearing	
Menstrual Irregularities	Infertility/Abortion	
Libido	Poor Memory /Difficulty inConcentration	
Behavioral Changes	Tremors	
Palpitation	irritability	

PAST HISTORY

HT/ Others

IHD

DIABETIC HISTORY

- Known Diabetic Since
- Whether on Regular Rx or not
- It Rx then what is the treatment on which the patient is
- Whether Diabetic Status Under Control
- When was the last Blood test done results

FAMILY HISTORY

Hypertension	Diabetes Mellitus	IHD
Hypothyroidism	Goiter	

PERSONAL HISTORY

Diet Menstrual History

Addiction: Tobacco Chewing/Smoking/Both

Alcohol-Occasional/Daily/Moderate/Heavy

TREATMENT HISTORY

GENERAL EXAMINATION

Height	Weight	BMI	Pallor
Icterus	Xanthelasma	Madarosis	
Pulse		Peripheral Pulsation	
B. P.	Lying		
	Standing		

Skin : Cold/Coarse/Moist/Dry/Yellowish Discoloration

Edema Facial Puffiness Alopecia Tongue

Thyroid Gland : Normal/Enlarged

SYSTEMIC EXAMINATION:

C. V. S.

R. S.

P/A

C. N. S.

INVESTIGATIONS:

Hb (gm%) TLC DLC P L E M B

ESR

FBS

PPBS HbA_{1C}

B. Urea S. Creatinine

ECG CXR

Thyroid Profile: FT3 FT4 TSH

Lipid Profile

TC TG HDL-C LDL-C

Urine spot PCR:

Fundus :

Peripheral neuropathy:

REMARK:

Signature of the guide